Common Streaming Protocol Specification

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Notice:

As of the date of publication, this document is a release candidate specification subject to DECE Member review and final adoption by vote of the Management Committee of DECE in accordance with the DECE LLC Operating Agreement. Unless there is notice to the contrary, this specification will become an adopted “Ecosystem Specification” on 15 September 2015.

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Contents

1 Introduction

1.1 Scope

This specification defines an Application Format that includes a Media Format and MPEG DASH (Dynamic Adaptive Streaming over HTTP) manifest and protocol profiles for adaptive streaming of media presentations optimized for Common File Format content and playback devices.

1.2 Document Organization

This document is organized as follows:

1. Introduction—Provides background, scope and conventions
2. Common Streaming and DECE Ecosystem
3. Common Streaming Publishing Model
4. Common Streaming Playback Model
5. Identification
6. General MPD Constraints
7. CSF Profile-specific MPD Constraints
8. Annex A, Example Media Presentation Descriptions
9. Annex B, Example Adaptation Sets

This specification is primarily a derivation of the normative references CFF [DMedia] and DASH [DASH].

1.3 Document Notation and Conventions

The following terms are used to specify conformance elements of this specification. These are adopted from the ISO/IEC Directives, Part 2, Annex H [ISO-P2H]. For more information, please refer to those directives.

- SHALL and SHALL NOT indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

- SHOULD and SHOULD NOT indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.
- MAY and NEED NOT indicate a course of action permissible within the limits of the document.

1.4 Normative References

1.4.1 DECE Normative References

The following DECE technical specifications are cited within the normative language of this document.

[DSystem]	System Specification
[DDMP]	Media Package Specification
[DMeta]	Content Metadata Specification
[DMedia]	Common File Format & Media Format Specification

1.4.2 External References

The following external references are cited within the normative language of this document.

[DASH]	ISO/IEC 23009-1:2014, “Dynamic Adaptive Streaming over HTTP”
[DASHIF-IDR]	DASH Industry Forum (DASH-IF), Identifier registry, http://dashif.org/identifiers
[SMPTE2053]	SMPTE ST 2053:2011, *Media Package for Storage, Distribution and Playback of Multimedia File Sets and Internet Resources*, July 13, 2011.
[ISO14496-12]	ISO/IEC 14496-12, Third Edition, "Information technology — Coding of audio-visual objects – Part 12: ISO Base Media File Format”, including Amendment 3 and prior amendments and corrigenda
[UNICODE]	UNICODE 6.0.0, “The Unicode Standard Version 6.0”, http://www.unicode.org/versions/Unicode6.0.0/

[TR-META-CM]	*Common Metadata,* TR-META-CM, v2.1b, July 12, 2013, Motion Picture Laboratories, Inc., http://www.movielabs.com/md/md/v2.1/Common_Metadata_v2.1b.pdf
[XSD-META-CM]	XML Schema to accompany [TR-META-CM], July 12, 2013, http://www.movielabs.com/schema/md/v2.1/md-v2.1.xsd
[ISO-P2H]	ISO/IEC Directives, Part 2, Annex H http://www.iso.org
[RFC4122]	Leach, P., et al, A Universally Unique IDentifier (UUID) URN Namespace, July 2005 http://www.ietf.org/rfc/rfc4122.txt

Note: Readers are encouraged to investigate the most recent publications for their applicability.

1.5 Informative References

The following external references are cited within the informative language of this document.

[DPublisher]	DECE Content Publishing Specification, Version 2.0
[CENC]	ISO/IEC 23001-7:2012, First edition 2012-02-01, "Information technology - MPEG systems technologies - Part 7: Common encryption in ISO base media file format files"

1.6 Terms, Definitions and Acronyms

DECE Media Package terminology is defined in [DSystem], Section 1.4.

Common File Format terminology is defined in [DMedia], Section 1.7.

Words intended to be interpreted as defined here are indicated by capitalization throughout the document. The same words written in lower case are intended to convey their generic English meaning.

Adaptation Set	As defined in [DASH], “a set of interchangeable encoded versions of one or several media content components.” As defined by CSF, a set of CSF Files that are seamlessly switchable.

Adaptive Streaming	Continuous internet download and playback of media Segments while automatically adjusting media bit rate (and possibly encoded picture size) by selecting from alternative Media Segments available from Web servers in order to dynamically adapt bitrate to network throughput without interrupting playback.
Common Streaming	A framework for publishing, streaming and playing media based on MPEG DASH [DASH] and Common File Format [DMedia].
Common Streaming Format (CSF)	Specialization of Common File Format for use in Common Streaming.
Common Streaming Profile	A Delivery Profile defined for Common Streaming
CSF Adaptation Set	One or more CSF Files that contain perceptually equivalent content and conform to CSF container and elementary stream constraints that make them seamlessly switchable during adaptive streaming and valid to be referenced by Representation elements within one AdaptationSet element in an MPD conforming to a CSF Application Profile.
CSF Application Profile	A DASH MPD Profile specified for use with Common Streaming Format Files and derived Media Segments optimized for interoperability among CSF implementations.
CSF File	A file that contains single-track CFF Container conforming to a Common Streaming Profile. A CSF File contains a single track of audio, video, or CFF-TT content.
CSF File Format	The combination of file, media, metadata, and encryption formats and constraints that define media files that conform to the Common Streaming Format.

CSF Group	One or more CSF Adaptation Sets that contain perceptually different content of the same track type (e.g. audio, video, or subtitles), only one Representation of which may be selected at a time for presentation during adaptive streaming. For example, a CSF Track File Group might contain multiple audio CSF Adaptation Sets, each containing a different audio language or codec.
CSF Media Profile	Constraints on the CSF File Format for video files that may be contained in Adaptation Sets identified by SDS and HDS Media Profile identifiers, defined in Appendix A of this specification.
CSF Segment	An individual network resource identified by HTTP-URL that is composed of a portion of a CSF Track File (e.g. a header or movie fragment corresponding to an Initialization Segment or Media Segment).
DASH	Dynamic Adaptive Streaming over HTTP, as specified by [DASH].
DASH Profile	A profile of DASH described in Section 8 of [DASH], which imposes a set of specific restrictions that may include constraints on the Media Presentation Description (MPD) document, Segment formats, Segment addressing protocol, and the encoding of content within segments to enable accessing and combining Segments for presentation. Not to be confused with Media Profile or Application Profile.
Delivery Profile	Requirements and constraints for delivery of Common File Format of a given Media Profile. Examples include, HD Download, HD Streaming, SD Download and SD Streaming
Group	As defined in [DASH], “collection of Representations that are expected to not be presented jointly.” In an MPD, the collection of AdaptationSet elements with the same @group attribute value and their contained Representation elements.
Index Segment	As defined in [DASH], “Segment that primarily contains indexing information for Media Segments.” In the CSF format, an ‘sidx’ Box or Segment.

Initialization Segment	As defined in [DASH], "Segment containing metadata that is necessary to present the media streams encapsulated in Media Segments." In CSF format, a CSF file header. In CFF format, a DCC header.
Media Presentation Description (MPD)	As defined in [DASH], "formalized description for a Media Presentation for the purpose of providing a streaming service." Note: The formalized description is an XML schema and an instance document of that schema is referred to as an MPD.
Media Segment	As defined in [DASH], "Segment that complies with media format in use and enables playback when combined with zero or more preceding segments, and an Initialization Segment (if any)." As applied to CSF, the body of a DASH HTTP response, corresponding to a movie fragment in the CSF media format.
Period	As defined in [DASH], "interval of the Media Presentation, where a contiguous sequence of all Periods constitutes the Media Presentation."
Representation	As defined in [DASH], "collection and encapsulation of one or more media streams in a delivery format and associated with descriptive metadata." Applied to CSF, a CSF File and the Representation element that describes it in an MPD.
SDS Media Profile	Standard Definition Media Profile for CSF streaming video files and Adaptation Sets.
Segment	As defined in [DASH], "smallest addressable unit in an MPD with a defined format." Applied to CSF, a Track File header or movie fragment accessed as the body of an HTTP response.

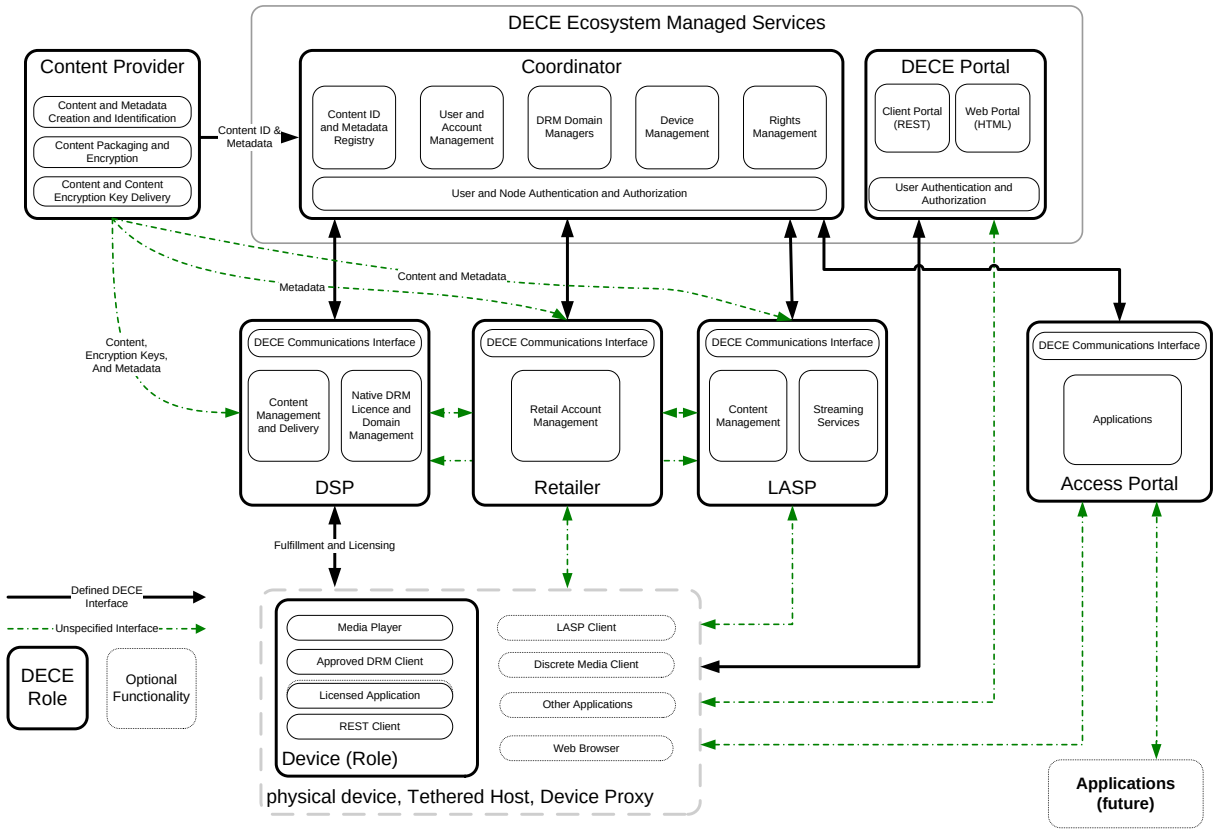
1.7 XML Change Management

Recipients of XML Documents encoded using this specification SHALL comply with XML Change Management defined in [DSystem], Section 1.6.

2 Common Streaming and DECE Ecosystem (Informative)

The DECE Ecosystem provides the means for LASPs to stream to LASP Clients which might be part of a Device, a web site, a device application or other form of player. A variety of streaming protocols are available for LASPs.

A standard streaming format protocol can reduce publishing costs (publish once) and implementation costs both at the server and the client. DECE defines such a format and protocol. The format definition is found in the DECE Common File Format and Media Specification [DMedia], and the protocol is found here. The streaming format is very similar to DECE's download format. The streaming protocol is based on Dynamic Adaptive Streaming over HTTP [DASH].



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Common Streaming is adaptive streaming using sets of Common File Format files and Common Encryption retrieved via the DASH Protocol.

Inherent in Common Streaming is Late Binding. Tracks that are played together are packaged independently and bound for playback at the Device.

CFF specifications allow the encoding of Single-Track DCC Files that can be used for both late binding download using a DECE Media Package [DMP], and DASH adaptive streaming. The DECE Media Package [DDMP] is designed to be compatible with Common Streaming. References to tracks can be local (in the DMP) or remote (on a server). The remote scenario is presumed to be Common Streaming. This supports scenarios such as playing video from a DMP while streaming a director's commentary audio track.

Devices can be designed to decode multi-track files, single track files, and DASH adaptive streams with minimal increase in parser, decoder, DRM, and display complexity.

3 Common Streaming Publishing Model

Content Providers publish Common File Format Containers in a format suitable for Streaming Servers to generate the elements essential for DASH streaming, such as Media Presentation Description (MPD), Initialization Segments and Media Segments. To allow efficient publishing while providing flexibility to the Streaming Server, the published format is packaged differently from the format downloaded by the player.

This section describes the various published components and the mapping from the published format to the format downloaded by the player.

Common Streaming requires a set of single track CFF Containers conforming to a Common Streaming Delivery Target as defined in [DMedia], Annex C. These can be referred to as Common Streaming Format (CSF) Containers. Each CSF Container has a single audio, video or subtitle track.

Common Streaming restricts each Adaptation Set to contain a single component type, such as audio, video, or subtitle. Media Segments may be selected in sequence from any Representation in an Adaptation Set, concatenated, and decoded without special "splicing" or reformatting by CFF decoders capable of dynamic sub-sampling and late binding. The combination of MPD switching constraints and CSF encoding constraints provide a well-defined Segment bitstream for reliable seamless decoding of movie fragments as specified in the Common File Format.

Content Providers publish a CSF Container for each Representation. Note that CSF Containers, by definition, contain a single encoding of a single track.

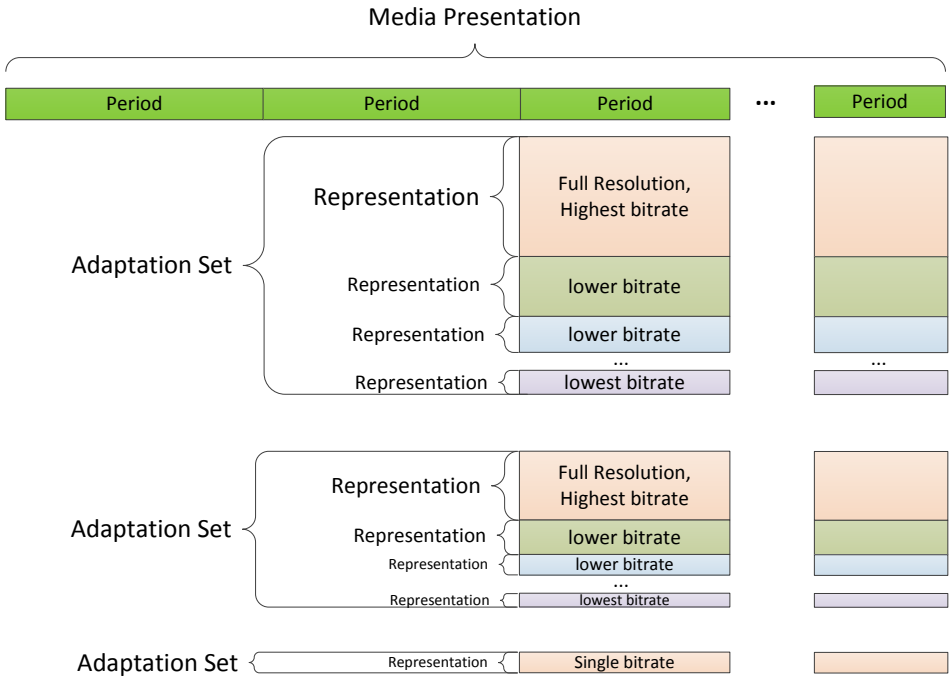
3.1 Presentation, Adaptation Set and Representation

DECE calls a collection of tracks that can be played together is called a Presentation. Common Streaming requires DECE Presentations with constraints that allow them to be adaptively streamed.

When publishing for Common Streaming, the publisher has the option of producing CSF Containers at different bitrates to support adaptive streaming. These containers are optimized for delivery at varying bitrates. A collection of media encodings that contains the same content, but differ in bitrate is an Adaptation Set. Each encoding is called, in DASH parlance, a 'Representation'. Representations are packaged by the publisher as single track CSF Files.

The following illustrates a DASH Media Presentation (DECE "Presentation") consisting of one Adaptation Set for each of audio, video and Timed Text in each Period. It also illustrates the each Representation

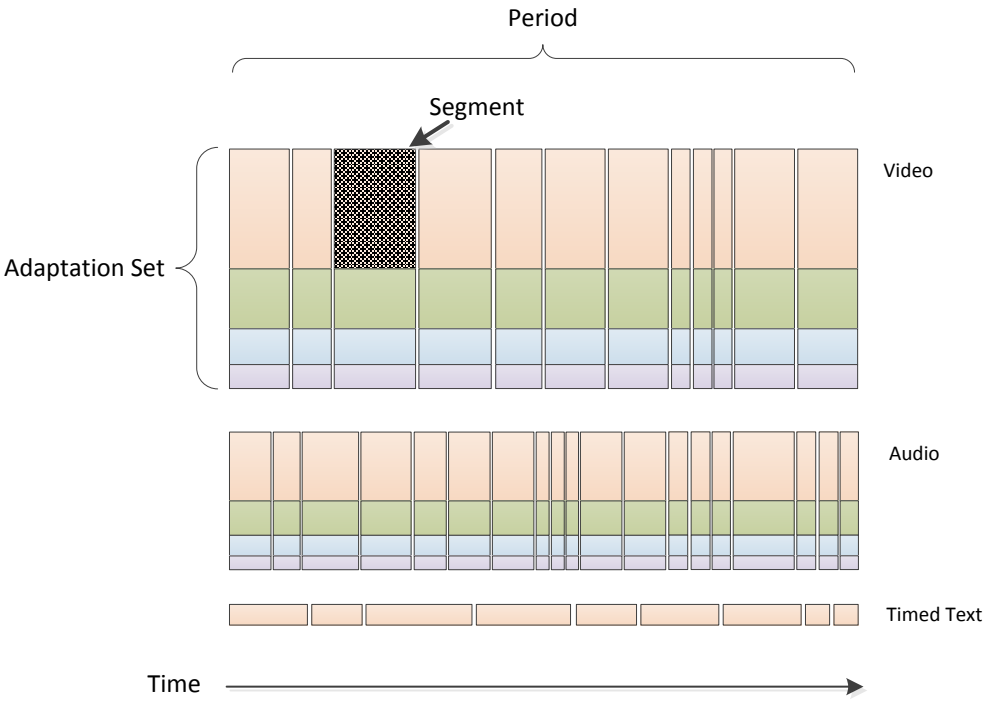
within the Adaptation Sets. Note that the Timed Text Adaptation Set has only one Representation, and Periods are not shown.



It is expected that multiple video tracks will be produced. It is possible that audio tracks will be produced, although this is less common. It is not expected that CFF-TT will be produced at varying bitrates although a publisher might produce both image and text tracks.

3.2 Periods and Segments

DASH divides the Media Presentation into a series of time periods. Each period contains Segments from Representations associated with that Period. The portion of a Representation associated with the Period is called a Segment. The Segment is essentially the atomic unit used in DASH. It is identifiable in the CSF File, it is referenced in the MPD document and it is the unit obtained by the player. The following figure illustrates the relationship between Representations, Periods and Segments.



A collection of Segments containing the same content (e.g., the same video track) but at different bitrate is called an Adaptation Set.

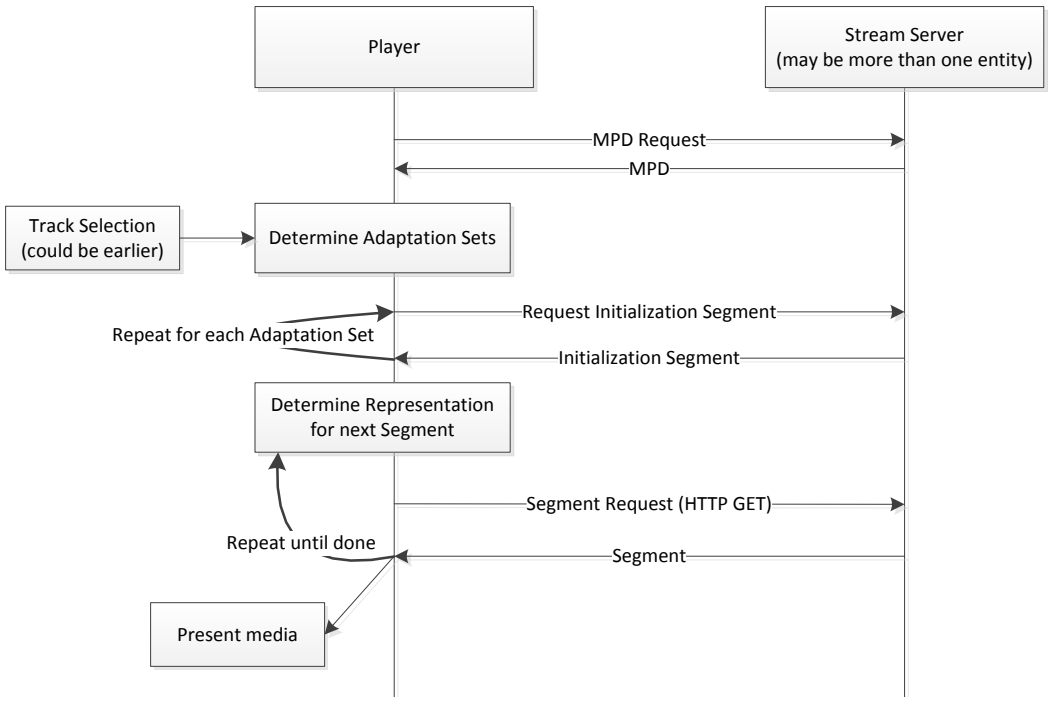
Common Streaming Adaptation Sets have constrained encoding parameters that enable CFF decoders to switch and splice movie fragments seamlessly. CFF streaming tracks uses short duration movie fragments so that adaptation is performed rapidly and can result in imperceptible quality changes if several bitrates with small differences are contained in an Adaptation Set. A user may also control switching between Adaptation Sets to change language, audio channel configuration, camera angles, etc. with acceptable response time.

4 Common Streaming Playback Model

The following playback model is assumed for Common Streaming. There are two primary entities, a Player and a Stream Server. Outside the scope of this model, the Player determines what content to stream and determines which MPD will provide stream information for that content.

The Player first requests and receives an MPD. The Player determines which Adaptation Sets to play based on the MPD and Track Selection. Note that Track Selection occurs outside the scope of this process. Then the Player retrieves Initialization Segments for each Adaptation Set selected.

The streaming process consists of repeatedly determining the appropriate next segment or segments to retrieve, retrieving those segments, decoding those segments and presenting the media. Decoding and presenting media is outside the scope of this document.



Content protection processes such as obtaining a license is required for some content. When Common Encryption is used, a license is generally obtained following Track Selection and prior to presenting media.

4.1 Player Overview

A DASH player downloads a Media Presentation Description (MPD) manifest specified in XML, containing AdaptationSet elements identified as belonging to different "Groups" (i.e. main audio, main video, and subtitle Groups). Different CSF Adaptation Set contains different audio, video, or subtitle content (e.g. a different language, camera angle, or media format). Each CSF Adaptation Set may contain multiple Representation elements that each reference a different CSF File. Each CSF File in a CSF Adaptation Set is a different encoding of the same source content, encoded at different bitrates (and video resolutions, in the case of a video Adaptation Set), constrained by the CSF specification to enable automatic seamless bitstream switching.

After parsing the MPD, a DASH player selects an Adaptation Set from each Group, and a CSF File from each CSF Adaptation Set to initialize, based on device capabilities (e.g. SD or HD, multichannel or stereo), user selection (e.g. audio language, subtitles on/off), network type, etc. The DASH player then downloads and processes one Initialization Segment (a CSF file header) for each CSF Adaptation Set to configure parsing, decoding, decryption, and display at a selected quality level. A DASH player will then download Media Segments from each selected Adaptation Set, each Media Segment containing a CSF Movie Fragment that can be sequenced, synchronized, and presented according to the MPD and CSF file presentation timelines. A DASH player may dynamically switch subsequent Media Segment download requests between CSF Files within each Adaptation Set to adapt to network conditions and maintain a continuous presentation at the highest bitrate the network allows. Bitrate switching gave "adaptive streaming" its name, but adaptation to different users and devices has become an important feature of DASH to support interoperability despite a growing number of streaming video media formats and device types.

Within the DASH standard, a Segments exists as an addressable HTTP Resource. It may be stored on an origin server as a CSF file, as one track in a CFF file, or as short files, each containing a single Segment named with the Segment URL indicated in the MPD. It may be found on the Internet via HTTP protocol, DNS, etc., or found in a local proxy cache delivered by some other method such as multicast, broadcast, peer to peer, or file download. Segments might not be stored as files on a Web server, but may be created as resources when requested from a live encoder or other storage format, either at the origin server or an edge server (on demand encoding and/or packaging). A DASH player can operate normally without awareness of the Segment delivery mechanism as long as URLs are properly resolved to Segments in the underlying device's network layer.

4.2 Adaptation Set Selection

An Adaptation Set selection process results in an identifier corresponding with an AdaptationSet/@id.

Because AdaptationSet/@id corresponds with track_ID in the 'tkhd' box as defined in [DMedia], the process for selecting a CFF track is the same as selecting an Adaptation Set. The Track Selection Process described in [DMeta], Annex A will correctly result in an AdaptationSet/@id.

Selection of Tracks for simultaneous playback SHALL NOT violate [DASH] constraints on simultaneous playback.

[DASH] defines a group as a 'collection of Adaptation Sets that are not expected to be presented simultaneously.'

4.3 Media Presentation Description (MPD)

The MPD is the mechanism the Server uses to communicate segment information to the Player.

Within the MPD is information to retrieve segments. The means for addressing segments is called a CSF Application Profile.

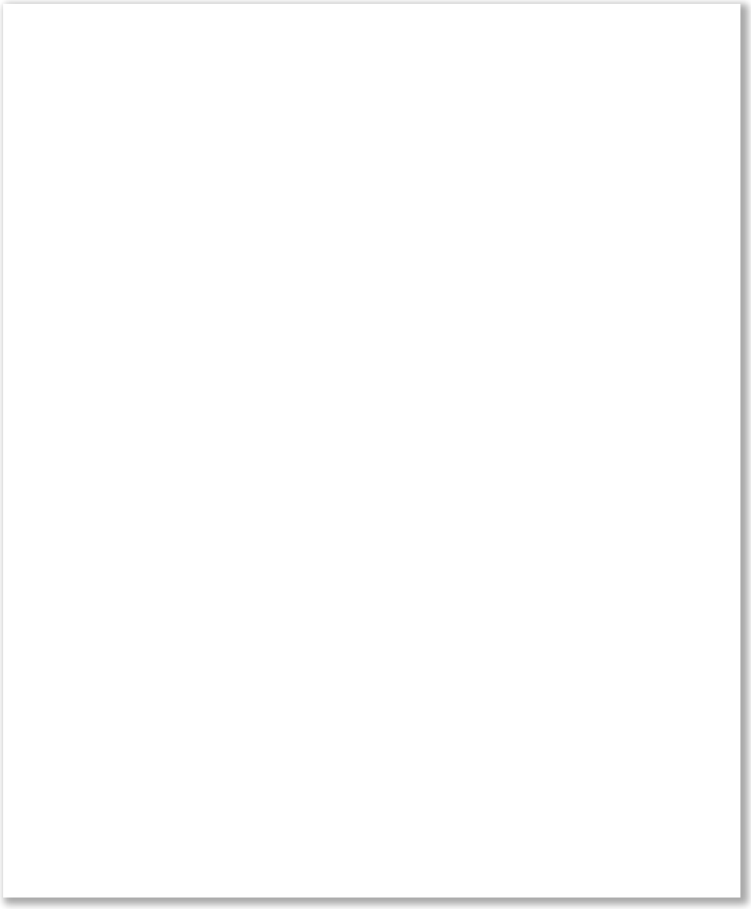
Note that CSF Files are defined independently of Application Profile and therefore support multiple Application Profiles.

4.3.1 Relationship between MPD and CSF Files

The MPD entries correspond with specific sections of CSF Files. For each Period, the MPD contains entries for each Adaptation Set, Groups within those Adaptation Sets, Representations within those Groups, and Segments within those Representations. Representations correspond with CSF Files and Segments correspond with portions of the CSF File.

For example, an MPD might include one Adaptation Set in Group 1 that corresponds to the main video. Two additional Adaptation Sets might be present in Group 5 that each contain primary audio, each containing English language, but with one being encoded as stereo AAC and the other as multi-channel audio ("MCA"), as demonstrated in the figure below. During playback, one would expect that the main video Adaptation Set in Group 1 and one of the primary audio Adaptation Sets in Group 5 would be presented. One might also expect to be able to select alternate Adaptation Sets within Group 5, such as to switch from stereo to multi-channel audio, though perhaps not seamlessly, just as one might do with tracks in a file conforming to the Media Profiles defined in [DMedia]. In addition, a device might dynamically and automatically switch between the Representations within an Adaptation Set that

contains alternative encodings of the same content in order to adapt bit rate and encoded resolution to network and device conditions. The CSF format constrains the encoding of tracks and files that may be referenced by Representations in an Adaptation Set so that CFF decoders that handle dynamic sub-sampling and late binding will be able to decode adaptively switched tracks as though they were delivered in a single CFF file.



4.3.2 CSF Application Profiles

Common Streaming requires players to support specified CSF Application Profiles, but allows players to support other profiles.

Required CSF Application Profiles are derived from DASH ISO Base media file Live Profile [DASH], Section 8.4, subsequently referred to as 'DASH Live Profile'. Common Streaming defines two CSF Application Profiles based on Dash Live Profiles. These CSF Application Profiles differ in the method of segment addressing:

- Sequence Number Addressing
- Segment Time Addressing

Each CSF Application Profile may be used with media that conforms to Streaming Media Profiles. CSF Application Profiles are described elsewhere in this document.

4.3.3 Obtaining an MPD

An MPD must be obtained by the player. Common Streaming assumes an MPD is retrieved using HTTP methods described in [DASH]. The exact mechanism for delivery is outside the scope of this document, but is defined in [DSystem].

Note that DECE defines a reference to the MPD in the Fulfillment Manifest as defined in [DSystem]. The methods for retrieving an MPD are the same as for retrieving the Manifest itself. That is, appropriate use of HTTP is defined in [DSystem], Section 11. The process consists of obtaining a Fulfillment Manifest document, then following the link in FulfillmentManifest/StreamingInfo/MPDLocation to get the MPD for the Presentation associated with PresentationID.

4.4 Streaming

4.4.1 Initialization

The Player may obtain an Initialization Segment for each Adaptation Set.

The Initialization Segment contains information to initialize the decoder in a manner suitable for the entire Adaptation Set. Note that although each fragment ('moof' Box) that contains information to initialize the decode for that segment, the Initialization Segment information describes the worst-case parameters across the entire Adaptation Set. It is therefore recommend that the Player use the information in the Initialization Segment for decoder setup.

4.4.2 Segment Retrieval and Playback

Adaptive Streaming is the process of delivering or, in the case of DASH, retrieving track segments with bitrates compatible with available bandwidth. In Common Streaming, the MPD describes which Segments can be played during a specific period. The Player is responsible for all decisions about what is downloaded and when it is downloaded.

4.4.3 Segment Storage and Access Model

In the case of the CSF byte range addressing Application Profile, movie fragments are referenced as DASH "Subsegments", and the complete CSF File is considered one Segment. A Subsegment byte range may include multiple movie fragments. The HTTP response for the same movie fragment will contain the same byte stream whether addressed by Subsegment byte range, Segment number, or Segment time.

The hypothetical storage model for Subsegments is that a server stores a full length CSF File containing movie fragment Subsegment indexed by a Segment Index ('sidx'), which can be downloaded by a DASH player to index those movie fragments using HTTP byte range requests.

The hypothetical storage model for Segments is that a server stores a separate file for each movie fragment using a unique filename and URL containing a number or time corresponding to the location of the movie fragment in the original CSF File.

For storage and processing efficiency, servers should store a single full duration CSF File for all three addressing schemes, and number or time addresses should be resolved to movie fragments by REST or script method, and an index other than the file directory system.

4.5 Licensing

The use of Common Encryption [CENC] with Common Streaming is explicitly supported and documented as appropriate here. This does not preclude the appropriate use other stream protection technologies with Common Streaming. DRM License acquisition is outside the scope of this document.

The KID associated with an Adaptation Set can be obtained from the ContentProtection element child of the AdaptationSet element for the Adaptation Set. This described in Section 6.3.3.

5 Identification

The Media Presentation Document refers to media and supporting data. This section defines how media and other data are referenced.

5.1 Summary of Identification

Following summarizes identification

Entity	Identification	Comments
MPD	PresentationID	
Representation	APID	Must correspond with a CFF compliant with a Common Streaming Profile as per [DMedia]
Adaptation Set	AdaptationSet/@id	@id corresponds with the track_ID in the 'thkd' Box in the CFF Files for that Adaptation Set.
Group	AdaptationSet/@group	The scope of @group is the MPD. Group is not used in Common Streaming.
Segment: DASH Live Profile, Sequence Number Addressing	Sequence number	Sequence number from range of sequence indicated MPD, starting with SegmentList/@startNumber
Segment: DASH Live Profile, Timestamp Addressing	Time	Specified in MPD's SegmentList/SegmentTimeline/S

5.2 Media Presentation and MPD Identification

5.2.1 Associating an MPD with a Media Presentation

Media Presentations is referred to using PresentationID as defined in [DSystem], Section 5.

MPD/@id SHALL be set to the PresentationID of the Media Presentation referenced by the MPD.

5.2.2 Uniquely identifying an MPD

MPDs are considered to be transient entities with no need of naming or identification. Therefore, DECE does not at this time standardize a mechanism for naming or identifying MPDs.

5.3 Representation Identification

A DECE Track as defined as per [DMedia]. A DASH Representation corresponds with a CFF Track.

Common Streaming Tracks are defined in terms of a Common Streaming Profile [DMedia]. Common Streaming Profiles are all single track per CFF. Therefore, a CSP CFF corresponds with exactly one

Representation. CSP CFFs are uniquely identified by an APID. It follows that that Representations can be referenced by APIDs.

5.4 Adaptation Set Identification

Tracks are selected based on Presentation as determined by PresentationID and Track_ID of tracks within that Presentation. As the MPD corresponds with only one Presentation there is no ambiguity.

If Track Selection is performed based on Container Required Metadata [DMeta], Section 4; or Coordinator Digital Asset Metadata [DCoord], Section TBS, TrackReference elements found in Audio, Video and Subtitle elements that reflect track_ID in the 'tkhd' Box in the CFF File. Note that all CFF Files in the same Adaptation Set have the same track_ID.

In the MPD, the AdaptationSet/@id attribute contains the value of track_ID in the CFF Files for that Adaptation Set.

5.5 Segment Identification

Segment identification depends on the DASH Profile.

Each CSF Application Profile uses a different Segment addressing protocol with different advantages.

5.5.1 Sequence Number Addressing and Segment Time Addressing

Sequence Number Addressing and Segment Time Addressing Profiles are both based on DASH Live Profile. They both therefore use a Segment URL "template" with substitution parameters such as $RepresentationID$, $Number$ and $Time$. Template addressing allows live streaming without requiring an MPD playlist download prior to addressing each new Media Segment, and also provides concise algorithmic address expression in MPDs for pre-recorded content. These two addressing methods differ as follows:

- **Sequence number addressing** (using the $Number$ Segment URL parameter) is assumed by the DASH standard to have Media Segments with relatively constant duration so the number of Segments determines the presentation time (i.e., *number* × *duration*) to an accuracy within a half-segment duration. Constant duration Segments are easiest to determine with prerecorded content. Number addressing can be used for live streaming, but synchronized server and client clocks are required to calculate when each Media Segment will become available in UTC time so a player can safely join the "live edge" of a live stream without causing network errors by requesting Segment numbers that haven't been encoded yet.

- **Segment time addressing** (using the $Time$ Segment URL parameter and SegmentTimeline element) allows variable duration (and discontinuous) Segments that are often caused by live encoding. A player can calculate the next Segment address by adding last received Segment duration to its start time, which results in the start time ($Time$ value) of the next Segment to be requested. SegmentTimeline element contains a Segment duration table listing all available Segments, and their durations in compressed form so a player joining a live presentation can request the most recent Segment in the table with no uncertainty or dependence on client and server UTC time synchronization. Segment Time addressing is optimized for low latency live presentations can be immediately converted to VOD as they are encoded. Variable duration and missing Segments that sometimes result during live encoding and splicing are recorded in the SegmentTimeline element so they will not interrupt live or "live to VOD" playback, ad insertion at Segment boundaries, and so forth.

5.5.2 Byte Based Addressing

Byte based addressing is based on DASH On Demand profile. Segments are Self-Initializing Segments and the (Sub) segments are aligned. (Sub) segments begin with Stream Access Points.

A DASH client downloads the 'sidx' box using a HTTP GET request based on the URL in the MPD. Following the index download, the client downloads self initializing segments using byte-based HTTP GET requests.

The 'sidx' Box can either be outside the stream or referenced as a byte range within the stream.

6 General MPD Constraints

The MPD constraints defined in this section are common to all of the CSF Application Profiles.

Media Presentation Descriptions used with the CSF Application Profiles SHALL comply with the constraints and requirements defined in [DASH] with the additional constraints defined here.

6.1 The MPD Element

The attribute MPD@type SHALL have the value “static”.

An MPD SHALL NOT include the MPD@minimumUpdatePeriod attribute.

An MPD SHALL include the MPD@mediaPresentationDuration attribute.

6.2 Periods

Multiple Periods MAY exist within a single MPD.

The duration of a Period SHALL NOT exceed the duration of the longest CSF Track File referenced within that Period.

The duration of a Period MAY be shorter than the duration of one or more CSF Files referenced with the Period, resulting in truncated playback of the CSF Track File(s).

The following calculations are defined by [DASH], but are included here informatively:

- MPD@mediaPresentationDuration corresponds with the total duration of the Presentation. That is, the duration of the Presentation was the User to play the Content from beginning to end.
- Period@duration corresponds with the total duration of the Period. Period@duration must be stated for the last Period, but other Period durations can be inferred by the start of the next Period.
- MPD@mediaPresentationDuration equals the sum of Period durations for all Period elements in MPD.

6.3 Adaptation Sets

An AdaptationSet references files from a single CSF Adaptation Set. Within an SDS or HDS Media Profile Adaptation Set, any Initialization Segment followed by a properly ordered sequence of Media Segments from any of the Representations it contains will form a valid CSF File.

Within an Adaptation Set, any Initialization Segment followed by a properly ordered sequence of Media Segments SHALL form a valid CSF File.

Multiple Adaptation Sets that comply with different Media Profiles or DASH profiles MAY exist in an MPD. Authors may assume that players ignore Adaptation Sets they cannot reproduce.

A single Adaptation Set SHALL NOT reference CSF Files from more than one CSF Media Profile. Note that Adaptation Sets within a given Media Profile may have different subsampled resolutions and different Profiles and Levels.

An Adaptation Set that contains more than one Representation SHALL have the following attribute values:

- The `@segmentAlignment` attribute SHALL have a value of “true”.
- The `@startWithSAP` attribute SHALL have a value of 1 or 2.
- The `@bitstreamSwitching` attribute SHALL have a value of “true”.

AdaptationSet@bitstreamSwitching applies to Representations within a single Adaptation Set. Adaptively switched Media Segments may be concatenated and decoded in standard CSF parser/decoders without media pipeline reinitialization. Per [DMedia], CSF files (i.e., those that meet a Streaming Delivery Target) are required to include inband parameter sets. To avoid reinitialization, decoders use these inband parameter sets for decoding.

AdaptationSet@segmentAlignment applies to Movie Fragment alignment within a CSF Adaptation Set. Time aligned Media Segments enable seamless switching within an Adaptation Set without bitstream and timeline editing.

6.3.1 Groups

The MPD supports the inclusion of Adaptation Sets for Content that should not be played simultaneously, such as video tracks from more than one Media Profile. DASH provides Group definitions to assist with this process; however, Common Streaming does not use this mechanism.

Adaptation Sets MAY use the [DASH] grouping mechanisms with the following constraints

- All video tracks SHALL be in the same Group
- All audio tracks SHALL be in the same Group
- All subtitle tracks, if any, SHALL be in the same Group

All Adaptation Sets that contain references to files in the same Group SHALL have the `@group` attribute set to a matching value.

Group indicates which tracks can be played simultaneously. As defined in [DMedia], Groups are assigned as follows:

track_ID range	Group	Track Type
1-49	1	Primary Video
50-99	2	Secondary Video
100-999	5	Main Audio
1,000-1,999	6	Secondary Audio
2,000-9,999	7	Tertiary Audio
10,000-10,999	3	Main Subtitle
11,000+	4	Secondary Subtitle

Only one track from any Group can be played simultaneously.

6.3.2 Stream Access Point (SAP)

Each Movie Fragment in a CSF Track File contains an integral number of Coded Video Sequences (video) or sync frames (audio). The attribute `@startWithSAP` (whether specified in the `AdaptationSet` or `Representation` elements) has a value of 1 or 2, corresponding with SAP types in [ISO-14496-12], Section I.3.

The attribute `@startWithSAP`, whether specified in the `AdapationSet` or `Representation` elements, SHALL have a value of 1 or 2.

In the case of a video track that has one or more movie fragments that start with a Random Access I-Picture, as defined in [DMedia], the attribute `@startWithSAP` SHALL have a value of 2.

6.3.3 Content Protection

AdaptationSet elements containing encrypted Representations SHALL include a DASH ContentProtection Descriptor of the following form, containing the cenc:default_KID attribute in the following form:

```
<ContentProtection schemeIdUri="urn:mpeg:dash:mp4protection:2011"
    value="cenc" cenc:default_KID=<KID>/>
```

Where <KID> is the KID (key id) associated with the Representations in the Adaptation Set.

For example: `<ContentProtection schemeIdUri="urn:mpeg:dash:mp4protection:2011" value="cenc" cenc:default_KID="34e5db32-8625-47cd-ba06-68fca0655a72"/>`

6.4 Representations

Each Representation SHALL correspond to exactly one CSF Track File that conforms to the CSF File Format.

6.4.1 ID

The `@id` attribute for a Representation contains the file name up to but not including the "*.ext*" of the CSF Track File specified in [DMedia], Annex E.5.

Within a Period, CSF Representations SHOULD be sequenced in order of decreasing bitrate. Note that players must sort by @bitrate attribute to determine initialization and quality/bitrate switching order of the Representations.

CSF Representations SHOULD have Representation@id="V"N, for video and = "A"N for audio where the variable N starts at 0 and increments by 1 for each Representation@id.

The `@id` attribute for a Representation SHOULD contain the complete file name up to but not including the extension (e.g. "V*x*_Q*y*" for video, "A*x*_Q*y*" for audio, and "S*x*" for subtitles).

Note that the naming conventions let a publisher determine the structure of MPDs created from the files they've encoded. MPDs can be automatically constructed using those filenames in the DASH URL templates and XML structure. Otherwise, the publisher would need to provide an MPD or equivalent to convey the structure that was encoded. The naming convention is just an optimization for a distributed ecosystem.

6.4.2 Width and Height

`Representation@width` and `Representation@height` correspond with the encoded and cropped horizontal and vertical sample counts, normalized to the vertical sample count. The `@width` and `@height` of a Representation—whether specified in the `AdaptationSet` or `Representation` elements—matches the width and height values, respectively, of the Track Header Box in the CSF Track File.

The `@width` and `@height` of a Representation SHALL match the normalized size of the CSF File it references.

The `@maxWidth` and `@maxHeight` of a video Adaptation Set SHALL match the largest normalized Representation `@height` and `@width`.

6.4.3 Segments and Segment Templates

6.4.3.1 Initialization Segment

As defined in [DASH], an Initialization Segment is an HTTP response, referenced by `Initialization` elements within an MPDs.

The body of an Initialization Segment for a Representation SHALL be the header of the CSF File associated with that Representation.

6.4.3.2 Media Segments

As defined in [DASH], a Media Segment is an HTTP response containing movie fragments referenced by a `media` element within an MPD.

The body of a Media Segment for a Representation SHALL be one or more CSF File movie fragments within the Representation.

Note that in the On Demand Profile, the entire file is called a Segment and Movie Fragments are called Subsegments. The specification always uses the term Segment to refer Movie Fragments, including On Demand Subsegments.

Segments SHALL only reference CSF Segments, as defined in each Application Profile (e.g. $Number$, $Time$, byte range).

6.4.3.3 Segment Templates

When used, Segment Templates comply with the following rules.

Segment Templates SHALL use URL construction as defined in Section 5.3.9.4.4 of [DASH], *"Template-based Segment URL Construction".*

6.4.4 Descriptors

Content Descriptors are specified for use with CSF Application Profiles as defined in [DASH], Section 5.8.4.

When Files contain metadata identifying ratings, accessibility, track roles, etc., AdaptationSet elements or Representation elements in the MPD SHOULD include content descriptor elements signaling that information to enable selection prior to media download. Note that use of DECE metadata is the preferred method of Content and track selection.

6.4.4.1 Role Descriptor

`Role` elements SHALL be encoded using the DASH role scheme as per [DASH] 5.8.5.5 with the following constraints:

- 'subtitle' – used for subtitles. Note that 'caption' is not used
- 'main' – used for main audio or video. Note that 'alternate', 'supplementary', 'commentary', and 'dub' are not to be used. These roles are addressed in metadata.

6.4.4.2 ContentProtection Descriptor

`AdaptationSet` elements containing encrypted Representations SHALL include a DASH `ContentProtection` Descriptor of the following form, containing the `cenc:default_KID` attribute and where <default_KID value> is the value of the tracks' KID:

```
<ContentProtection schemeIdUri="urn:mpeg:dash:mp4protection:2011"
    value="cenc" cenc:default_KID=<default_KID value>/>
```

`AdaptationSet` elements containing encrypted Representations SHOULD include DASH `ContentProtection` Descriptor elements for each supported DRM system of the following form:

```
<ContentProtection schemeIdUri="urn:uuid:xxxxxxxx-xxxx-xxxx-xxxx-xxxxxxxxxxxx"
   value="DRMNAME version"/>
```

Where the UUID is equal to the SystemID of the DRM system defined for use in the Protection System Specific Header Box ('pssh'), and the value attribute string is defined by the DRM system.

DRM systems MAY specify the option or requirement to include a "pssh element" in `ContentProtection` Descriptors with their @schemeIdUri of the following form:

```
<ContentProtection schemeIdUri="urn:uuid:d0ee2730-09b5-459f-8452-200e52b37567"
       value="acme 2.0" cenc:default_KID="34e5db32-8625-47cd-ba06-68fca0655a72">
```

```
        <!-- base64 encoded contents of 'pssh' box with this SystemID -->
        <acme:pssh>mFzZTY0IGVuY29kZWQgY29udGVudHMgb2YgkXBzc2iSIGJveCB3aXRoIHRoaXMgU3lzdGVtS
        </acme:pssh>
</ContentProtection>
```

6.4.4.3 FramePacking Descriptor

For AVC the FramePacking Descriptor SHALL be
`'urn:mpeg:dash:14496:10:frame_packing_arrangement_type:2011'`

For HEVC the FramePacking Descriptor SHOULD be in accordance with DASH-IF registry at [DASHIF-IDR].

6.4.4.3.1 Other Descriptors

All other Descriptors MAY be included provided they do not conflict with other metadata describing the CSF File.

The following table describes appropriate use of other descriptors.

Descriptor	Recommended Usage
ContentProtection	Can be used to support Approved Stream Protection Technologies.
Role	May be used to identify roles, but this should not be the primary means of describing an Adaptation Set. The required Role is defined in metadata.
Accessibility	Should not be used because accessibility track selection is defined by metadata.
Rating	Should not be used because ratings information is defined in metadata. The [DASH] Role has no defined controlled vocabulary.
Viewpoint	May be used to identify viewpoint
FramePacking	Not applicable
AudioChannelConfiguration	Not applicable

For example, ContentProtection can be included to support acceptable Approved Stream Protection Technologies.

The Rating descriptor SHOULD NOT be used as there is no established definition for its encoding.

There are other mechanisms for obtaining equivalent information.

6.4.5 Dependent Representations

Any Representation that meets the definition of 'dependent Representation' in [DASH] SHALL be handled in as a dependent Representation as specified in [DASH]. For example, the @DependencyID attribute must include appropriate reference to the complimentary Representation.

Dolby Vision Enhancement Layer, as defined in [DMedia], Section B.7 is a dependent Representation.

Dolby Vision Enhancement Layer Representations SHALL be in a different Adaptation Set and Group from the Base Layer's complimentary Representation.

7 CSF Application Profile-specific MPD Constraints

This section defines the specific Media Presentation Profiles that are supported for the Common Streaming Format. These profiles are derived from profiles specified in [DASH] and define the constraints and requirements necessary to:

- Map CSF Adaptation Sets and Groups to Media Presentation Description (MPD) entries
- Map CSF File structures and parameters to MPD structures and attributes
- Specify semantics for each field

7.1 ISO Base Media File Format Live Profile Constraints

7.1.1 General Live Profile Constraints

This section defines constraints common to all CSF Profiles that use the "ISO Base media file format live profile" (ISO Live profile) defined in Section 8.4 of [DASH].

- Segment Templates SHALL be used in all Adaptation Sets or Representations to reference CSF Resources.
- Segment URLs (whether defined in Segment Templates or elsewhere) SHALL be consistent with CSF Track File naming conventions specified.
- An Initialization Segment SHALL be present for each Representation.
    - The URL template of Initialization Segments SHALL be set to the value "$RepresentationID$_init.*ext*", where '.*ext*' is the appropriate file extension for the CSF Track File.
- One or more Media Segments SHALL be present for each Representation. Each Media Segment SHALL correspond to a Movie Fragment in the CSF File associated with that Representation.
- An Index Segment SHALL NOT be present in a Representation.

7.1.2 CSF Sequence Number Profile

The CSF Sequence Number Profile is derived from and SHALL comply with all of the constraints and requirements of "ISO Base media file format live profile" (ISO Live profile) defined in Section 8.4 of [DASH] as amended in 1) Section 7.1, ISO Base Media File Format Live Profile Constraints, and 2) this

section. In cases where there is a difference from the ISO Live profile, this specification SHALL take precedence.

This profile addresses each Movie Fragment using a simple indexing scheme in which the Media Segments are numbered in sequential order equal to the `sequence_number` value in the Movie Fragment Header Box (`'mfhd'`) of each DCC Movie Fragment. This CSF Application Profile can support presentations, without requiring any special knowledge of the internal properties of each Movie Fragment (such as timing information or size).

The CSF Sequence Number Profile includes all of the constraints defined in Section 7.1.1, with the following additional constraints:

- An MPD that complies with this CSF Application Profile SHALL include the following profile identifier in MPD@`profiles`: (note that other applicable profiles are also included)

  `http://www.decellc.org/schema/2014/11/profiles/dash/SEQNO_1`

- The URL template of Media Segments SHALL be set to the value "$RepresentationID$_$Number%06d$.*ext*", where '.*ext*' is the appropriate file extension for the CSF File.

- SegmentTemplate@`startNumber` SHALL have a value of 1.

- The duration of all Media Segments in a Representation except the last one SHALL be approximately the same, as required by DASH.

- The duration of the last Media Segment in a Representation MAY be different than other Movie Fragments in the container.

7.1.3 CSF Time Profile

The CSF Time Profile is derived from and SHALL comply with all of the constraints and requirements of "ISO Base media file format live profile" (ISO Live profile) defined in Section 8.4 of [DASH] as amended in 1) Section 7.1, ISO Base Media File Format Live Profile Constraints, and 2) this section. In cases where there is a difference from the ISO Live profile, this specification SHALL take precedence.

This profile addresses each Movie Fragment using a Segment URL containing the fragment's `baseMediaDecodeTime` stored in the Track Fragment Base Media Decode Time Box (`'tfdt'`) of each fragment. A Segment Timeline table SHALL be included in the MPD to provide an index between Segment number and presentation time. The sum of each Media Segment's duration and its start time

provides the time address the next Segment in the current Representation, as well as all other Representations in the same Adaptation Set.

Time addresses are useful in broadcast systems where variable Segment duration may result from the combination of live and recorded content with different durations, shortened Segments at splice points, variations in real-time elementary stream encoding, etc. Time addressing is also useful in synchronizing multiple independent encoders to the same program, synchronizing multiple live channels, describing some modes of ad insertion, and time addressing portions of 24x7 channels for network PVR functionality.

The CSF Time Profile includes all of the constraints defined in Section 7.1.1, *General Live Profile Constraints*, with the following additional constraints:

- An MPD that complies with this CSF Application Profile SHALL include the following profile identifier in MPD@`profiles`: (note that other applicable profiles are also included)

  `http://www.decellc.org/schema/2014/11/profiles/dash/TIME_1`

- Segment Templates SHALL use URL construction as defined in Section 5.3.9.4.4 of [DASH].

- One or more Media Segments SHALL be present for each Representation. Each Media Segment SHALL correspond to a DCC Movie Fragment in the CSF Track File associated with that Representation.

- The URL template of the Media Segments SHALL be set to the value "$RepresentationID$_$Time%06d$.*ext*", where '.*ext*' is the appropriate file extension for the CSF File.

- SegmentTemplate@`timescale` SHALL have a value that matches the `timescale` field of the Media Header Box (`'mdhd'`) of all CSF Files referenced by Representations to which the SegmentTemplate applies.

- A SegmentTimeline element SHALL be present in each Segment Template to specify the timing information of the Media Segments and to support the $Time$ URL template parameter.

7.2 ISO Base Media File Format on Demand Profile Constraints

This section defines constraints common to all CSF Profiles that use the "ISO Base media file format On Demand profile" (ISO On Demand profile) defined in Section 8.3 of [DASH]. The On-Demand profile is intended to provide basic support for video on demand streaming. The primary constraints imposed by this profile are the requirement that each Representation is provided as a single Segment, that (Sub)

segments are aligned across Representations within an Adaptation Set and that (Sub) segments must begin with Stream Access Points. This permits scalable and efficient use of HTTP servers and simplifies seamless switching. In cases where there is a difference from the ISO On Demand profile, this specification SHALL take precedence. The CSF On Demand Profile includes all of the constraints defined in Section 8.3 [DASH], with the following additional constraints:

- An MPD that complies with this CSF Application Profile SHALL include the following profile identifier in MPD@`profiles`:

  `http://www.decellc.org/schema/2014/11/profiles/dash/VOD_1`

- All Representations SHALL contain a BaseURL element.
- Each representation SHALL contain a single Segment Index 'sidx' box.
- The manifest MPD SHALL contain a @indexRange attribute for every representation to assist with downloading the Segment Index box.
- The duration of all Media (Sub) Segments in a Representation except the last one SHALL be approximately the same, as required by DASH. This requirement forces that the AdaptationSet@subsegmentAlignment be to "true".
- All (Sub) Segments SHALL are self initializing and begin with either SAP 1 or a SAP 2 frame.
- All Representations SHALL follow 'avc3' based in-band signaling of codec parameters to allow for seamless switching.

To enable seamless trick modes, the following requirements apply:

- A trick play video Representation SHALL contain only SAP type 1 pictures and SHALL be stored in a separate trick play Adaptation Set from normal Representations of the same video source content.
- Trick play Representation elements SHALL include the attribute @codingDependancy set to 'false', and the attribute @maxPlayoutRate set to the maximum decodable frame rate determined by the video codec Profile and Level indicated in the @codecs parameter (codec Level max macroblocks per second/macroblocks per picture).
- A trick play video Adaptation Set SHALL contain one or more trick play video Representations.
- A trick play video Adaptation Set SHALL contain an EssentialProperty Descriptor element with @schemeIdUri equal "http://dashif.org/guidelines/trickmode" and containing the @value attribute equal to the @id attribute(s) of the normal Adaptation Set(s) containing

Representations of the same video content. The @value attribute may equal a white-space separated list of AdaptationSet@id values. In this case the trick mode Adaptation Set is associated to all Adaptation Sets listed.

Annex A. Example Media Presentation Descriptions (Informative)

This annex provides examples of Media Presentation Descriptions that comply with the CSF Application Profiles defined in Section 3. DECE is primarily interesting in delivering a similar user experience to UltraViolet CFF download with UltraViolet streaming, and DECE Application Profile constraints are mainly intended for efficiency in publishing and testing.

The DASH streaming standard has considerable flexibility, but limited media specification and no guarantees of end to end interoperability. Industry fora, such as "DASH Industry Forum" are creating recommendations, tools, and tests for DASH interoperability with media formats similar to CSF. DASH/CSF Application Profiles should be a proper subset of DASH IF recommendations, and DASH streaming implementation and interoperability will likely be solved outside of DECE for a wide range of applications.

A.1. Example MPD for CSF Sequence Number Profile

The following is an example MPD using the CSF Sequence Number Profile defined in Section 7.1. This example could be used for both video-on-demand (VOD) and live encoding applications with little more than changes to MPD@type and MPD@mediaPresentationDuration values.

This example provides two Selectable Track File Sets for video (HD and SD profiles). It is understood that a playback client might not support dynamically selecting among alternate video profiles, and even if one did, it would likely not be able to make the switch seamlessly. Doing so would most likely require pre-fetching licenses for each of the video profiles prior to starting playback, as well as complex handling of picture scaling and partial decoding of segments when switching between profiles since segments are not guaranteed to be aligned between different Adaptation Sets.

In addition to the video tracks, the example also provides Selectable Track File Sets for both audio and subtitles, offering English and French encodings of each.

For actual applications, additional content descriptors should be included in the Adaptation Sets to identify Role, Accessibility, Content Protection, and other properties to aid in track selection and acquisition of DRM licenses.

Note: Comments are included in parenthesis.

Table D - 1 – Example MPD for CSD Sequence Number Profile

```
<?xml version="1.0" encoding="UTF-8"?>
<MPD
```

```
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="urn:mpeg:DASH:schema:MPD:2011"
  xsi:schemaLocation="urn:mpeg:DASH:schema:MPD:2011"
  type="static"
  mediaPresentationDuration="PT60M"       (Actual duration for VOD)
  minBufferTime="PT3S"
  profiles="urn:mpeg:dash:profile:isoff-live:2011,      (multiple compatible profiles may be listed)
            http://www.schemas.uvvu.com/profiles/dash/SN_1/032012>

  <BaseURL>http://cdn1.example.com/location/Title/</BaseURL>   (Primary server)
  <BaseURL>http://cdn2.example.com/location/Title/</BaseURL>   (Alternate server)
(BaseURL SHOULD NOT be included, so all relative references are resolved relative to the MPD URL)

  <Period>
    <!-- Video Selectable Track File Set (Group #1) -->
    <!-- HD Video -->
    <AdaptationSet
        group="1"                              (Main video in group #1, HD video option)
        mimeType="video/vnd.dece.mp4"           (UV MIME type for High Def video)
        codecs="avc1.4D400F"                   (CSF HD Media Profile = AVC High Profile @ Level 4)
        frameRate="24000/1001"
        width="1920"                           ('tkhd' width – nominal display width)
          height="1080"                           ('tkhd' height – nominal display height)
      segmentAlignment="true"
      bitstreamSwitching="true"
        startWithSAP="1">
      <SegmentTemplate
        initialisation="$RepresentationID$init.uvv"     (DCC Header)
        media="$RepresentationID$$Number%06d$.uvv"      (Sequence Number indexing)
        startNumber="1"                                 (Media indexing starts at n=1)
        duration="2" />
      <Representation id="V1_Q0_" bandwidth="14000000" />
      <Representation id="V1_Q1_" bandwidth="10000000" />
      <Representation id="V1_Q2_" bandwidth="8000000" />
      <Representation id="V1_Q3_" bandwidth="6000000" />
      <Representation id="V1_Q4_" bandwidth="4000000" />
      <Representation id="V1_Q5_" bandwidth="3000000" />
      <Representation id="V1_Q6_" bandwidth="2000000" />
      <Representation id="V1_Q7_" bandwidth="1000000" />
    </AdaptationSet>
    <!-- SD Video (optional) -->
    <AdaptationSet
        group="1"                              (Main video in group #1, SD video option)
        mimeType="video/vnd.dece.mp4"           (UV MIME type for Standard Def video)
          codecs="avc1.1D300F"                 (CSF SD Media Profile = AVC Constrained Baseline @ Level 3)
         frameRate="24000/1001"
          width="854"                             ('tkhd' width – nominal display width)
          height="480"                            ('tkhd' height – nominal display height)
      segmentAlignment="true"
        bitstreamSwtiching="true"
      startWithSAP="1">
      <SegmentTemplate
        initialisation="$RepresentationID$init.uvv"     (MIME type file extension for SD video)
        media="$RepresentationID$$Number%06d$.uvv"
        startNumber="1"
        duration="2" />
      <Representation id="V2_Q0_" bandwidth="4000000" />
```

```
      <Representation id="V2_Q1_" bandwidth="2000000" />
      <Representation id="V2_Q2_" bandwidth="100000" />
      <Representation id="V2_Q3_" bandwidth="768000" />
      <Representation id="V2_Q4_" bandwidth="512000" />
      <Representation id="V2_Q5_" bandwidth="256000" />
    </AdaptationSet>
        <!-- Audio Selectable Track File Set (Group #2) -->
    <!-- English Audio -->
    <AdaptationSet
        group="2"                              (Main audio in group #2, English option)
      mimeType=" video/vnd.dece.mp4"         (UV MIME type for audio)
      codecs="mp4a.40"
      lang="en"
      segmentAlignment="0">                  (Alignment unnecessary when only one Representation exists)
      <SegmentTemplate
        initialisation="$RepresentationID$init.uva"     (MIME type file extension for audio)
        media="$RepresentationID$$Number%06d$.uva"
        startNumber="1"
        duration="4" />
      <Representation  id="A1_Q0_" bandwidth="64000" />
    </AdaptationSet>
    <!-- French Audio -->
    <AdaptationSet
        group="2"                              (Main audio in group #2, French option)
      mimeType="audio/dece.uva"
      codecs="mp4a.40"
      lang="fr"
      segmentAlignment="0">
      <SegmentTemplate
        initialisation="$RepresentationID$init.uva"
        media="$RepresentationID$$Number%06d$.uva"
        startNumber="1"
        duration="4" />
      <Representation id="A2_Q0_" bandwidth="64000" />
    </AdaptationSet>

          <!-- Subtitle Selectable Track File Set (Group #3) -->
    <!-- English Subtitle -->
    <AdaptationSet
        group="3"                              (Subtitles in group #3, English option)
      mimeType=" video/vnd.dece.mp4"
      codecs="cfft"
      lang="en"
      segmentAlignment="0">
      <SegmentTemplate
        initialisation="$RepresentationID$init.uvt"     (MIME type file extension for subtitles)
        media="$RepresentationID$$Number%06d$.uvt"
        startNumber="1"
        duration="0" />                        (Undefined subtitle segment duration for VOD)
      <Representation id="S1_" />
    </AdaptationSet>
    <!-- French Subtitle -->
    <AdaptationSet
        group="3"                              (Subtitles in group #3, French option)
      mimeType=" video/vnd.dece.mp4"
      codecs="cfft"
      lang="fr"
      segmentAlignment="0">
```

```
      <SegmentTemplate
        initialisation="$RepresentationID$init.uvt"
        media="$RepresentationID$$Number%06d$.uvt"
        startNumber="1"
        duration="0" />
      <Representation id="S2_" />
    </AdaptationSet>
  </Period>
  (Repeat for additional Periods, if any, sequenced within the MPD)
</MPD>
```

A.2. Example MPD for CSF Time Profile

The following is an example MPD using the CSF Time Profile defined in Section 7.1.3. This example provides a single HD video track at eight seamlessly switchable bit rates, as well as a pair of Selectable Track File Sets for English and French audio. The video and audio Representations specify repeating Media Segments with 2.002-second durations each. The instance of the MPD shown accounts for 1799 continuous segments, representing a duration of up to about one hour.

For actual applications, additional content descriptors should be included in the Adaptation Sets to identify Role, Accessibility, Content Protection, and other properties to aid in track selection and acquisition of DRM licenses.

The SegmentTimeline provides a complete random access index to movie fragments both by 'moof' Sequence_number and by 'tfdt' Base media decode time, i.e. track decode time and presentation time.

Note: Comments are included in parenthesis.

DRM system may also specify additional elements and attributes that may be used for license acquisition or other functions of the identified DRM system.

For Example: A DASH MPD may include the following Content Protection Descriptors to indicate that the 'cenc' scheme (Common Encryption) was used to encrypt the referenced media, and provide license acquisition information for one (or more) DRM system(s) with the indicated SystemID. This particular DRM Content Protection Descriptor uses the SystemID UUID format defined in DASH section 5.8.5.2 [3], and defines an extension element in its namespace (acme:) that contains the contents of a 'pssh' box with that SystemID. It also uses the `cenc:default_KID` attribute.

```
<ContentProtection schemeIdUri="urn:mpeg:dash:mp4protection:2011"
    value="cenc" cenc:default_KID="34e5db32-8625-47cd-ba06-68fca0655a72"/>

<ContentProtection schemeIdUri="urn:uuid:d0ee2730-09b5-459f-8452-200e52b37567"
        value="2.0" cenc:default_KID="34e5db32-8625-47cd-ba06-68fca0655a72"/>

        <!-- base64 encoded contents of 'pssh' box with this SystemID -->
```

```
        <acme:pssh>
           YmFzZTY0IGVuY29kZWQgY29udGVudHMgb2YgkXB
           zc2iSIGJveCB3aXRoIHRoaXMgU3lzdGVtSUQ=
        </acme:pssh>
</ContentProtection>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<MPD
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="urn:mpeg:DASH:schema:MPD:2011"
  xsi:schemaLocation="urn:mpeg:DASH:schema:MPD:2011"
  type="static"                          (type="static" for VOD)
  mediaPresentationDuration="PT300M"      (Actual duration for VOD)
  minBufferTime="PT3S"
  profiles="urn:mpeg:dash:profile:isoff-live:2011,
        http://www.schemas.uvvu.com/profiles/dash/T_1/032012>  (multiple compatible profiles may be listed)

  <BaseURL>http://cdn1.example.com/live/pagent2011/</BaseURL>                  (Primary)
  <BaseURL>http://cdn2.example.com/liveservices/pagents/20111225/</BaseURL>  (Alternate)
  (If BaseURL SHOULD NOT be included, all relative references are resolved relative to the MPD URL)
  <Period>
    <!-- Video Selectable Track File Set (Group #1) -->
    <!-- HD Video -->
    <AdaptationSet
        group="1"                              (Main video in group #1, HD video)
        mimeType="video/vnd.dece.mp4"           (UV MIME type for High Def video)
        codecs="avc1.4D400F"                   (CSF HD Media Profile = AVC High Profile @ Level 4)
        frameRate="30000/1001"
        width="1920"                           ('tkhd' width – nominal display width)
          height="1080"                          ('tkhd' height – nominal display height)
      segmentAlignment="true"
      bitstreamSwtiching="true"
        startWithSAP="1">
      <SegmentTemplate
        initialisation="$RepresentationID$init.uvv"     (DCC Header)
        media="$RepresentationID$$Time%06d$.uvv"        (Sequence Number indexing)
        timescale="90000" />                            (Media indexed by 90 kHz ticks)
        <SegmentTimeline>
          <S t="0" d="180180" r="1798"/>  (Start time, segment duration and repeat count of Segments)
        </SegmentTimeline>
      </SegmentTemplate>
      <Representation id="V1_Q0_" bandwidth="10000000" />
      <Representation id="V1_Q1_" bandwidth="7000000" />
      <Representation id="V1_Q2_" bandwidth="5000000" />
      <Representation id="V1_Q3_" bandwidth="4000000" />
      <Representation id="V1_Q4_" bandwidth="3000000" />
      <Representation id="V1_Q5_" bandwidth="2000000" />
      <Representation id="V1_Q6_" bandwidth="1000000" />
      <Representation id="V1_Q7_" bandwidth="512000" />
    </AdaptationSet>

        <!-- Audio Selectable Track File Set (Group #2) -->
    <!-- English Audio -->
    <AdaptationSet
        group="2"                              (Main audio in group #2, English option)
```

```
      mimeType="audio/vnd.dece.uva"       (UV MIME type for audio)
      codecs="mp4a.40.5"
      lang="en"
      segmentAlignment="0">               (Alignment unnecessary when only one Representation exists)
      <SegmentTemplate
        initialisation="$RepresentationID$init.uva"     (MIME type file extension for audio)
        media="$RepresentationID$$Time%06d$.uva"
        timescale="48000" />                            (Media indexed by 48 kHz ticks)
        <SegmentTimeline>
          <S t="0" d="96096" r="1798" />
        </SegmentTimeline>
      </SegmentTemplate>
      <Representation  id="A1_Q0_" bandwidth="64000" />
    </AdaptationSet>
    <!-- French Audio -->
    <AdaptationSet
        group="2"                           (Main audio in group #2, French option)
      mimeType="audio/dece.uva"
      codecs="mp4a.40.5"
      lang="fr"
      segmentAlignment="0">
      <SegmentTemplate
        initialisation="$RepresentationID$init.uva"     (MIME type file extension for audio)
        media="$RepresentationID$$Time%06d$.uva"
        timescale="48000" />
        <SegmentTimeline>
          <S t="0" d="96096" r="1798" />
        </SegmentTimeline>
      </SegmentTemplate>
      <Representation id="A2_Q0_" bandwidth="64000" />
    </AdaptationSet>
  </Period>
  (Repeat for additional Periods, if any, sequenced within the MPD)
</MPD>
```

Example of AdaptationSet@bitstreamSwitching="true", and $Time$ addressing with SegmentTimeline and variable duration Media Segments

```
<?xml version="1.0" encoding="utf-8"?>
<MPD
     id="OptionalPresentationNameForHumanConsumption"
     xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
     xmlns="urn:mpeg:dash:schema:mpd:2011"
     xsi:schemaLocation="urn:mpeg:dash:schema:mpd:2011 DASH.xsd"
     profiles="urn:mpeg:dash:profile:isoff-live:2011
     http://microsoft.com/ms-dash.docx" type="static"
     minBufferTime="PT2S"
     mediaPresentationDuration="PT52.2499583S"
     >
      <Period>
          <AdaptationSet
              id="0" group="5"
              lang="en"
              contentType="audio"
              segmentAlignment="true"
              bitstreamSwitching="true"
              profiles="http://microsoft.com/csf"
              mimeType="audio/mp4"
              codecs="mp4a.40.2">
```

```
<SegmentTemplate
     timescale="10000000"
     media="QualityLevels($Bandwidth$)/
      Fragments(audio_eng=$Time$,format= mpd-time-csf)"
     initialization="QualityLevels($Bandwidth$)/
      Fragments(audio_eng=i,format= mpd-time-csf)">
       <SegmentTimeline>
          <S d="20201360"/>
          <S d="20201361"/>
          <S d="20201360"/>
          <S d="20201360"/>
          <S d="20201361"/>
          <S d="20201361"/>
          <S d="20201360"/>
          <S d="20201134"/>
          <S d="20201361"/>
          <S d="20201360"/>
          <S d="20201361"/>
          <S d="20201134"/>
          <S d="20201360"/>
          <S d="20201361"/>
          <S d="20201360"/>
          <S d="20201361"/>
          <S d="20201133"/>
          <S d="20201361" r="1"/>
          <S d="20201360"/>
          <S d="20201361"/>
          <S d="20201133"/>
          <S d="20201361" r="1"/>
          <S d="20201360"/>
          <S d="17414966"/>
       </SegmentTimeline>
     </SegmentTemplate>
     <Representation
          id="A1"
          bandwidth="125576"
          audioSamplingRate="48000"/>
     </AdaptationSet>
     <AdaptationSet
          id="1"
          group="1"
          contentType="video"
          segmentAlignment="true"
          bitstreamSwitching="true"
          profiles="http://microsoft.com/csf/HD"
          mimeType="video/mp4"
          codecs="avc1.640028"
          maxWidth="1920"
          maxHeight="1080"
          frameRate="24000/1001">
     <SegmentTemplate timescale="10000000"
       media="QualityLevels($Bandwidth$)/
        Fragments(video=$Time$,format= mpd-time-csf"
       initialization="QualityLevels($Bandwidth$)/
        Fragments(video=i,format= mpd-time-csf)">
          <SegmentTimeline>
          <S d="20000000" r="18"/>
          <S d="39999583"/>
          <S d="20000000" r="4"/>
          <S d="2500000"/>
          </SegmentTimeline>
     </SegmentTemplate>
     <Representation
          id="V1"
          bandwidth="5933486"
          width="1920"
          height="1080"/>
```

```
            <Representation
                 id="V2"
                 bandwidth="3360441"
                 width="1280"
                 height="720"/>
            <Representation
                 id="V3"
                 bandwidth="2222352"
                 width="960"
                 height="540"/>
            <Representation
                 id="V4"
                 bandwidth="985321"
                 width="640"
                 height="360"/>
            <Representation
                 id="V5"
                 bandwidth="391544"
                 width="320"
                 height="180"/>
        </AdaptationSet>
    </Period>
</MPD>
```

END